Ministry of Agriculture and Food
Ontario

ORDER NO. 88-035
FEBRUARY 1988
AGDEX 774

Factsheet

WATER SOURCE HEAT PUMPS

(Revision of Factsheet "Water Source Heat Pumps", December 1982)

Helmut Spieser, Energy Engineer

The geothermal energy storage capacity of soil or groundwater can be used by water source heat pump to heat and cool your home or barn and supply hot water. Groundwater or the soil adjacent to your buildings is capable of providing or receiving heat. The heat pump is able to move and upgrade the heat to a useable temperature very efficiently.

HEAT PUMP OPERATION

A water source heat pump operates like a giant refrigerator that is reversible. A refrigerator moves heat from inside the cabinet and dumps it to the air in the room. A water source heat pump moves heat from groundwater to a heat use in winter, but can be reversed to put heat back into groundwater for cooling in the summer.

The heat movement occurs by circulating a working refrigerant (freon) through the heat pump system. As the low temperature gaseous refrigerant passes through one heat exchanger coil it absorbs heat energy from the warmer groundwater in the adjoining coil. This happens because heat energy will always flow from a warm substance to a cool substance. A compressor then moves this refrigerant at high pressure to another heat exchanger located in the heat use area. Here the heat is transferred usually to air and provides space heating. When cooling is required, refrigerant flow is reversed. The refrigerant now absorbs heat from the air and expells it to the groundwater.

Heat pumps provide more energy than they consume. Unlike natural gas, fuel oil, or electric resistance heating systems, a heat pump system does not consume energy to create heat. It uses electricity to collect and transfer heat that is already available in the surrounding environment. A heat pump uses energy only to run the fan and the compressor. As the name implies, a heat pump only "pumps" heat from one location to another location.

A heat pump is unique in that it can upgrade low grade sources of heat. This means that the heat pump can take a low temperature heat, upgrade it, and put it into the building at a higher temperature.

COEFFICIENT OF PERFORMANCE

The most remarkable property of the heat pump is probably the efficiency with which it uses electricity to achieve the transfer of heat energy from one location to another. The efficiency of a heat pump is expressed as its "coefficient of performance" or "COP". The coefficient of performance is merely a ratio of total energy output to total energy input. For water source heat pumps this COP can be as high as 4.0. What this means is that for each $1 worth of electricity put into the heat pump, it can supply $4 worth of heat output. The higher the COP, the more efficient the heat pump.

Heat pumps are usually rated in Tons. This can be converted to heating or cooling capacity in BTU's. 1 Ton = 12,000 BTU/h.

TYPES OF HEAT EXTRACTION SYSTEMS

Different ways can be used to extract heat from the ground. These systems can be broken down into two main types; open and closed-loop systems.

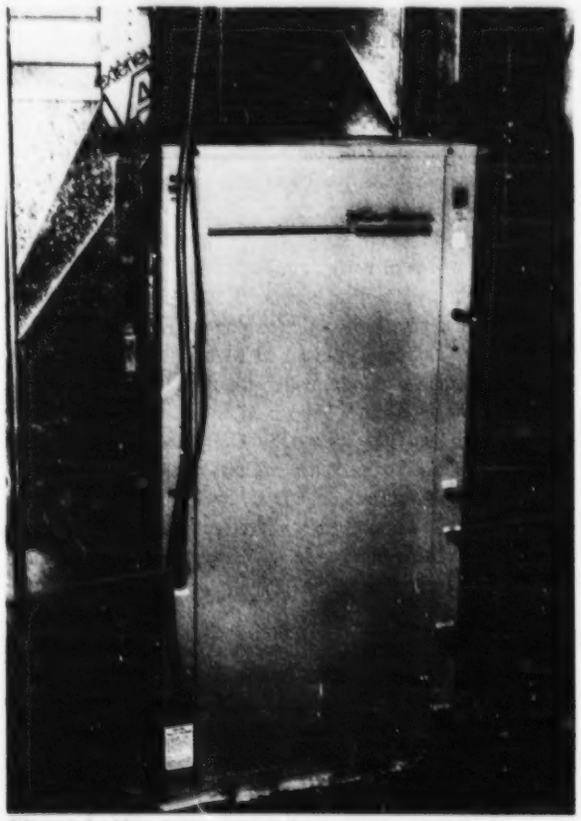


Figure 1. This water source heat pump not only heats the house it preheats the domestic hot water as well.

89-01127/

In an open system water directly from a well is pumped to the heat exchanger of the heat pump, heat is extracted, then the cooled water is discharged. This water can be discharged to a drainage ditch, a pond, or reinjected into the ground through a second well. The lowest water temperature which can be used in an open system is 4°C (40°F). Most heat pumps require from 9 to 14 litres per minute (2 to 3 gallons per minute) of water flow per Ton of heat pump capacity.

If a two well system is used, the wells must be physically separated to avoid short circuiting of cooled discharge water into the supply well. Since water is taken from a well through the heat pump in this system, hard water or water high in salts could cause scale buildup, thereby reducing efficiency. New cupro-nickel heat exchangers tend to minimize this scale buildup. The biggest problem with the open system is not finding water, but rather, finding a suitable means of discharging the cooled water. The cost of drilling a second well will vary depending on the sub-strata. In gravelly or sandy soils a horizontal, perforated tube with stone envelope can be used.

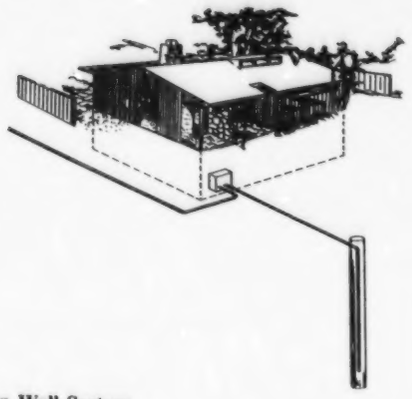
The closed-loop system is one means of eliminating the problems of obtaining and discharging suitable amounts of water. With the closed-loop system 32 mm (1 1/4 in.) polyethylene pipe is buried approximately 1.5 m (5 ft.) deep in the ground. This horizontal ground loop is installed in a field or yard adjacent to the building to be heated or cooled. Ground loops can be installed as a single pipe per trench or multiple pipes per trench. The amount of pipe required per Ton of heat pump capacity will vary depending on the configuration of the ground loop. As the number of pipes per trench increases, so will the loop length required per Ton – but the amount of trench required will decrease. The ends of the loop are connected to the heat pump. A circulation pump moves the water/antifreeze solution in the ground loop to move heat to the building or away from the building.

In areas where space does not exist to install a horizontal ground loop, vertical loops can be used. The vertical loop systems consists of the same 32 mm polyethylene pipe inserted into a series of vertically bored holes. Two polyethylene pipes connected with a special "U" shaped connector are placed into each bore hole which can be up to 30 m deep. The vertical loops are then joined and routed to the heat pump where a circulation pump moves the water/antifreeze solution. The cost to install a horizontal or vertical ground loop, for the same size heat pump, is likely to be comparable depending on local contractor equipment/experiences.

Free flowing streams, abandoned wells, and small lakes, can under certain circumstances be effective heat sources for a water source heat pump. In such situations they must be evaluated on an individual basis.

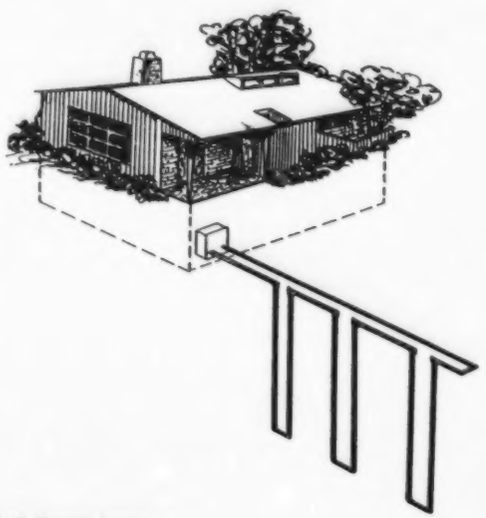
COST

Water source heat pumps at present are more costly than conventional forced air furnaces. However, when air-conditioning is required and detailed payback calculations are done, water source heat pumps often have a cost recovery period of under five years.



Open Loop Well System

Horizontal Ground Loop



Vertical Group Loop

FURTHER INFORMATION

Ontario Ministry of Agriculture and Food Factsheets:

- *Horticultural Uses of Water Source Heat Pumps*, Order No. 85-091
- *Heat Pumps in Agricultural Uses*, Order No. 86-031

12M
ISSN 0225-7882